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NO. 36 SUMMER 1957

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REVIEWS AND ABSTRACTS

In this section of the N.A.A.S. Quarterly Review, it is intended to survey current research and experiment in agriculture, horticulture and the allied sciences applicable to the work of the National Agricultural Advisory Service. It will not be possible, of course, to cover more than a small part of this wide field in each issue.

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The Use of Toxic Chemicals in Agriculture

E. J. MILLER

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THE DISCOVERY during the war of the remarkable insecticidal properties of DDT gave a tremendous fillip to the search for chemicals with similar powers. As a result, there has been for the past decade a flood of new compounds, a flood which shows no sign of abating.

Developments were rapid in the early stages. As new chemicals became available they were quickly brought into extensive use. But some of these early compounds were highly toxic, not only to pests, but also to the users, and, as is inevitable when development is very rapid, accidents happened, with fatal results to workers both in this country and overseas.

As soon as the danger was evident in this country, the Minister of Agriculture and Fisheries appointed a Working Party under the chairmanship of Professor (now Sir Solly) Zuckerman, C.B., F.R.S., on 30th July, 1950, to look into the problem urgently.

The Working Party's main recommendation was that legislation should be enacted to ensure that users of toxic chemicals in agriculture are protected against the effects of such substances by means of suitable protective measures. The Agriculture (Poisonous Substances) Act of 1952 was the direct result. Regulations made under this Act are issued jointly by the Minister of Agriculture, Fisheries and Food, and the Secretary of State for Scotland after they have consulted, as required by the Act "such organizations as appear to them to represent the interests concerned" (i.e., the industry, and farmers' and agricultural workers' trade associations).

The Consumer's Risk

In May 1951, the Working Party was reappointed and given a second task—to look into the risks to the consumer of foodstuffs that had been treated with toxic chemicals *at some stage*, whether as a growing crop or in store after harvesting.

This proved a harder task than the first, and the Second Report was not ready until April 1953. It said, in effect, that efficient agricultural practice necessitated the use of various chemicals to protect growing and harvested crops; that, so far as could be seen, no one had died from eating food treated in such a way, but that an element of risk existed and the problem should be watched. It went on to suggest that a permanent committee should be set up to advise appropriate government departments on the problem.

The recommendations were accepted by the Government and a committee was formed in March 1954. Very shortly afterwards its Scientific Subcommittee was set up.

Effects on Flora and Fauna

In May 1953, the Working Party was again reconstituted and charged with the task of investigating the possible risks to the natural flora and fauna of the countryside from the use on agriculture of toxic substances, including possible harmful effects on agriculture and fisheries. It issued its Third Report in May 1955, when it advised that the committee set up as a result of the recommendations in the Second Report should include risks to wild life in its terms of reference.

Membership of the Interdepartmental Advisory Committee on Poisonous Substances used in Agriculture and Food Storage consists of one or more representatives from the departments most concerned—the Ministry of Agriculture, Fisheries and Food, the Ministry of Health, the Board of Trade, the Department of Agriculture for Scotland, the Department of Health for Scotland and the Government Chemist, as well as the Agricultural and Medical Research Councils and the Nature Conservancy. The function of the Committee is to advise its member departments on all risks involved in the use of toxic chemicals in agriculture and food storage; thus the subjects of all three Reports of the Working Party are covered.

Panels to Assist the Scientific Subcommittee

The Scientific Subcommittee, which held its first meeting in May 1954, consists of specialists and includes a chemist, toxicologist, biochemist, plant pathologist, entomologist, the technical secretary of the Food Standards Committee, the secretary of the Crop Protection Products Approval Scheme, a scientist from the Nature Conservancy and medical experts from the Ministry of Health and the Department of Health for Scotland. Its function is to submit technical advice to the main committee. To facilitate its work, the Subcommittee forms panels to discuss specific problems. On such panels may serve, not only members of the Subcommittee, but also representatives of Trade Associations, firms, and other organizations. So far, panels have been set up to discuss analytical work, inhalation risks run by agricultural workers when using poisonous chemicals, arsenicals, organo-mercury compounds, and a voluntary notification and clearance scheme for the safe use of pesticides. An Antibiotics Panel has recently been formed in conjunction with the Preservatives Subcommittee of the Food Standards Committee.

The Collection of Data

Briefly the main work of the Secretariat of the Subcommittee is to obtain information on pesticides (this term is used to cover all crop protection chemicals such as insecticides, acaricides, fungicides, herbicides, growth suppressors, antibiotics and also rodenticides) under four headings:

1. Risks to users.
2. Risks to consumers of treated foodstuffs.
3. Risks to wild life.
4. Risks to "third parties"—children, animals, passers-by, and so on.

Information is collected from all possible sources; published and unpublished literature, research and experimental stations, the makers of pesticides, and from universities at home and abroad.

A summary of the information is prepared and, together with copies or summaries of leading papers, is presented to the Subcommittee. On the basis of this information, and with the aid of the specialized knowledge of its members, the Subcommittee makes recommendations to the Advisory Committee. This body considers them and endorses or refers them back. If endorsed, they go to government departments, and if accepted by them are passed on to the Trade, the National Farmers' Union and other interested bodies, as well as the official Agricultural Advisory Services. Plans have been made to widen the distribution of the recommendations considerably.

The information collected deals directly or indirectly with the safe use of poisonous chemicals. Whilst it obviously covers the toxicity of the chemical, it also extends to methods for analysing residues of the pesticide in foodstuffs. *It does not cover the biological efficiency of pesticides*, which is the province of the voluntary Crop Protection Products Approval Scheme administered by the Ministry of Agriculture, Fisheries and Food.

From the beginning, the Subcommittee has been aware that the most serious shortage of information concerns the risk to the consumer arising from residues in food. After the pesticide has been applied to a crop many factors affect the level of residue in the harvested crop. Frequently there will be no residue—the material will not survive the buffeting it receives from the weather, if on the outside of the plant, or the metabolic processes, if it is a systemic and so inside the plant. If it does survive and is present in the harvested crop, it may be there in its original form or as one or more metabolites; these may or may not be toxic, and if toxic may be more or less toxic than the parent compound. The amount present will be small, however, and may be quoted in terms of parts, or fractions of a part, per million. To devise methods which detect what is present and determine it in such small quantities is no mean task, requiring highly skilled workers and adequate laboratory facilities, and it is not surprising therefore that this side of the problem has been somewhat neglected. It is now being tackled in this country by the establishment of a small unit in the Government Laboratory to examine, assess and improve methods of residue analysis to a stage where collaborative analysis can be carried out and an agreed method reached. The unit has commenced an examination of residue analysis methods for dimefox, demeton-methyl

and organo-mercury compounds, whilst at the Long Ashton Research Station of the University of Bristol, Dr. J. T. Martin (a member of the Subcommittee) has started collaborative work with the Ministry's Infestation Control Division on DDT and *gamma*-BHC residues in grain.

Safeguards for the Agricultural Worker

The Agriculture (Poisonous Substances) Regulations were first drawn up following the passing of the Agriculture (Poisonous Substances) Act in 1952. Their aim is to protect the worker by specifying the protective clothing to be worn when carrying out certain operations using "scheduled substances". At present only the more toxic chemicals are scheduled; they consist of organo-phosphorus and dinitro-compounds and, when used as aerosols in glasshouses only, organo-mercury compounds. If the more volatile toxic organo-phosphorus compounds are used a respirator has to be worn at all times; at the other end of the scale protection is called for only when handling the concentrated pesticide. Of the various hazards run by the worker when using pesticides, that of inhaling the vapour is generally agreed to be one of the major risks; yet very little information exists on this aspect.

Following the publication of the Act in 1952, the Ministry and the National Farmers' Union jointly asked the British Standards Institution to issue a standard for both gas and dust respirators that would give the agricultural worker the protection called for by the Act. The British Standards Subcommittee charged with this task soon found that although it could—and did—produce a provisional standard (B.S.2617:1955) it would not be able to complete its task until it had scientific information on the inhalation hazards. Accordingly, towards the end of 1955, the Ministry appointed two scientists to investigate these hazards by means of laboratory and field trials. Reports on trials involving the use of DNC in the field and ethylmercury phosphate in glasshouses have now been made.

An important recommendation in the Second Report of the Zuckerman Working Party concerned the notification to government departments of new pesticides and new uses of existing pesticides before placing them on the open market. The idea was that, by purely voluntary means, firms would obtain official agreement to the safety of their product before it was used on foodstuffs intended for human consumption. Discussions on such a scheme have been in progress for some time between the two sides.

In the meantime, many firms have been taking part in an unofficial notification scheme for pesticides, and most of the Subcommittee's time has been taken up with the consideration of new chemicals which are about to be placed on the market. The Subcommittee recognizes that it has a tremendous job before it in dealing with the backlog of

chemicals already on the market, and it has therefore placed the more toxic ones in an order of priority. Several have been dealt with, and at the moment the organo-mercury compounds are receiving attention.

Since its inception, the Subcommittee has initiated recommendations which have been endorsed and issued by government departments covering 13 chemicals: aldrin, chlorobenzilate, demeton-methyl ("Metasystox"), demeton, diazinon, dieldrin, dimefox, "Dipterex", Griseofulvin, malathion, maleic hydrazide, monuron (CMU), and schradan.

How is a Decision Reached ?

When considering a chemical the Subcommittee follows the line that the distributor (that is, the firm that packs and labels the product in the form it is purchased by the user) is in the best position to know on which crops the product is likely to be most useful. Therefore it considers, *from the safety aspect*, the crops mentioned by the distributor and frames its recommendations accordingly. If it is satisfied that the evidence produced shows that the residues, if any, in the crop will be harmless (so far as our present knowledge allows us to say) then it will agree to the use of that chemical on that crop. The biological effectiveness of the chemical is not its concern. If the crop is one that is widely consumed all the year round, such as potatoes, brassicas and peas, the residue data required will need to be comprehensive. On the other hand, when crops are consumed in small amounts over the season, such as cucumbers, or in larger amounts over a short season, such as strawberries, or are industrial, such as hops and sugar beet, or when there is a long interval between the normal time of application and harvesting the crop, such as in winter brassicas, the demand for data is less exacting. Should the information be meagre the Subcommittee could, if it felt the circumstances warranted such action, reinforce the information supplied by the use of analogy or commonsense, so as to be able to reach a decision. Our present knowledge, however, is such that an adequate background of information has yet to be built up. Bearing this in mind, and allowing for the unpredictable ways of nature, it is thought advisable to confirm by experiment what may in theory appear obvious. The Subcommittee is therefore constantly seeking from firms residue data on crops even when, from the start, it appears that there will be little or no residue.

Ideally, the Subcommittee would like to say: this chemical may be used on any crop at any time provided that, when the crop is harvested for consumption, the residue is either nil or so low as to be harmless to the consumer. Until residue analysis difficulties are overcome, the Subcommittee is attempting to safeguard the consumer in another way by suggesting restrictive conditions of use, namely, use on specified crops only, maximum rates of application and minimum intervals between last application and harvest. It feels that if these suggestions are followed, the crop on harvesting will either contain no chemical, or

the residue will be so small that it will be virtually harmless. It recognizes that this view will be dependent upon good agricultural practice being followed throughout—but it also knows that, as these chemicals are costly, and involve the use of expensive machinery and labour, they will not be applied lavishly, and that most people using them are aware of the need to be circumspect.

December 27th, 1956.

Intensive Stocking of Grassland

C. R. W. SPEDDING

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HIGH ANIMAL PRODUCTION per acre from grassland implies high rates of stocking and, frequently, increased intensity of grazing management. Since parasitism of grazing stock has been found to be considerably influenced by both these factors, it is important to consider the parasitological consequences of intensive stocking. The parasites which are of greatest economic importance in most parts of the country fall into two main categories: stomach and intestinal worms in sheep and lungworms (husk) in cattle. Before considering these parasites in detail, however, it is desirable to understand something of the processes of infection and reinfection and the factors that affect both their rate and magnitude.

The salient features of the life-cycle of most of these worms are as follows. Eggs (in the case of stomach and intestinal worms) or minute larvae (in the case of the lungworms of cattle) are passed in the faeces of infected animals and develop to an infective stage. This takes at least three days, the precise rate of development depending on the temperature, and only larvae at the infective stage can infect another animal. The ability of the infective larvae to migrate from the faeces to the grass depends on the species, temperature and humidity. On the grass they are ingested by the grazing animal; if not, they eventually die. The larvae of stomach and intestinal worms survive rather longer than lungworms, but the weather is an important determining factor. Hot, dry weather is most likely to kill them, cold weather is less potent, and a warm, humid climate the most favourable for the development and survival of most of these worms in the pasture phase.

Bearing in mind that many factors affect the precise survival period, it may be said that about 50 per cent of the larvae of sheep worms die out in about three weeks, and about 90 per cent in one month [1], but the pasture cannot be regarded as completely free for something like two years [2]. Lungworms generally survive for a much shorter period and, although they have been known to survive for nearly a year [3], it is more usual to find only an extremely small number surviving for more than two to four months.

From the time when an infective larva is acquired by the animal during grazing, three weeks elapse before it becomes adult and starts to reproduce. One important feature that should be stressed is the fact that no multiplication occurs within the animal (as in a bacterial infection, for example), and every worm, apart from occasional larvae in drinking water etc., must be picked up from the pasture. It is for this reason that pasture management so greatly influences the process of reinfection and that grazing management may be used to control it. It is clear that almost anything that is done on or to a sward, including leaving it alone, will influence the process of reinfection to some extent.

This process may be considered in three parts: the infection passed on to the ground in the faeces; the period during which the infection is on the pasture; and the infection that is subsequently picked up by the grazing animal.

Infection in the Faeces

Several factors influence the number of eggs (or larvae) in the faeces; only the most important are listed here. The *class of stock* determines the prevalent species of parasites involved and, generally, the higher the proportion of older, resistant animals, the lower will be the rate of reinfection. A *low plane of nutrition* tends to exaggerate both the level of infestation and its effects. The *initial level of infestation* is becoming increasingly recognized as of importance [4]. The *stocking rate* also has a considerable influence and, obviously, the greater the number of animals, the greater the number of eggs being passed on to a given acre.

The Pasture Phase

Three main factors govern the amount of infection that survives from one grazing period to the next. The weather is the most important, but the length of the rest period between grazings determines to what extent it may operate. Effects of climate, however, must depend upon the degree to which the infective larvae are exposed to them, and this is greatly influenced by the length and density of the sward.

Infection ingested by the Grazing Animal

This will be a product of the number of infective larvae on each pound of herbage and the amount eaten by the host. Where the infection is not uniformly distributed over the pasture, selective grazing behaviour may reduce the number picked up compared with a random sample. Only a small percentage of larvae ingested actually establishes itself in the host: this depends primarily upon the resistance of the animal. Resistance may be acquired after a previous infection, or it may be of genetic origin. It tends to increase with age and is adversely affected by poor nutrition.

It is clear that grazing management affects most of the factors mentioned and influences the precise effect of those (e.g., the weather)

which are independent of it. There is little difficulty in devising managements which confer a high degree of control; it is far more difficult to devise one which at the same time sacrifices nothing of established value in good farming practice, and is both practicable and flexible enough to fit into a variety of agricultural systems. This point is well illustrated by the results so far obtained with sheep.

Worms in Sheep

The most important feature of recent research in this field has been the increasing emphasis placed on the damage suffered at sub-clinical levels of infestation [5]. There is little doubt that even well-managed sheep suffer some retardation of growth rate due to quite light worm burdens. At the present time, grazing management is the most effective weapon with which to combat low-level infestation. It is possible, by close-folding over clean pasture, to rear "worm-free" lambs whilst grazing them with their infected ewes. This has been done, chiefly on leys sown on land that has carried no ruminant stock for two years, by moving the sheep every two days from the day the lamb is born until weaning time [2, 5 and 6]. The method is rather laborious and requires a considerable acreage of clean pasture, since the lambs must not return to an area once grazed. In practice, the difficulties are very real but experimentally, worm-free lambs at pasture are of great value, however they are achieved.

A Worm-free Flock

As a development from this, the possibility is being investigated of weaning worm-free ewe lambs on to worm-free pasture with a view to producing a worm-free flock. The folding management would thereafter be unnecessary. The point of immediate practical application, however, is that such folding eliminates reinfection. Even if carried out across a pasture not completely clean, it would prevent direct reinfection and limit the amount picked up to what was already on the sward. Thus, by moving sheep every two days (and in practice this could safely be extended to three or four days) direct reinfection is avoided. This might be well worth while at critical times of the year when the rate of reinfection is normally rapid. In general, this rate will coincide with rapid grass growth, both being influenced by temperature and moisture.

Because rapid folding would limit reinfection to the numbers of infective larvae remaining from the previous grazing, the length of the rest period would be of considerable importance, and anything that could be done to lengthen it without reinfecting the pasture would be advantageous. The possibilities include cutting for conservation and grazing with mature cattle.

What has been said so far is related to the present problem of obtaining more efficient control of worm-infestation in sheep. The problem to be anticipated is concerned with increased stocking rates. If a

farmer is advised to improve the production of his grassland and he intends to utilize it by increasing his sheep stocking rate, it is important to understand the parasitological consequences. It is also desirable to know what part management can play in mitigating any adverse effects. These questions are being investigated and only tentative conclusions can be put forward. It seems that a substantial increase in stocking rate, where sheep are set-stocked, will result in an increase in the level of parasitism. There are exceptions to this but, in general, the level of parasitism will tend to increase to a greater extent than the increase in stocking rate. There is some evidence, however, that where sheep are being moved rapidly (e.g., every four days) the level of parasitism is independent of the stocking rate.

For control of most worms in sheep, therefore, the main principle may be stated as rapidity of movement [7]. The major exception to this would seem to be *Nematodirus* spp.

Nematodirus Infestation

This may be regarded as a lamb-to-lamb disease, the bulk of the infection acquired by one year's lambs being derived from that laid down by the lambs of the previous year [8]. The grazing management of the lambs is therefore of less consequence, since the magnitude of the infestation depends upon the number of infective larvae already on the pasture.

As far as can be indicated at present, the main principles of control may be summarized as follows: Firstly, avoid grazing lambs on pasture that carried lambs the previous year. Secondly, where that is not possible, avoid the pasture that carried lambs in the previous year, during the period when most of the infection was being passed in the faeces. This would normally be mid-May to mid-July [9] but may vary with the date of lambing. Thirdly, graze this infected area intensively with cattle or older sheep when the number of infective larvae per pound of herbage tends to be at its peak. This may vary slightly with the weather and may not be the same in different parts of the country. In the north-east it occurs in late April and early May; in the south it appears to be much earlier—about the end of January.

Husk in Cattle

There are several ways in which this problem differs from that of worms in sheep. Although sheep suffer from lungworm infestation they do not harbour the species responsible for husk in cattle. Sheep may therefore be used to lengthen the rest period from one grazing to the next without adding infection to the pasture. Thus, alternate stocking appears helpful in the control of husk.

The infective lungworm larvae migrate from the faeces far less than do those of stomach and intestinal worms. Faeces and infection, where it is present, may be regarded as synonymous. Thus operations such

as gang-mowing or harrowing, which spread the faeces about, may be assumed to distribute infection. Whether this is for good or ill will depend upon the subsequent weather. In hot, dry conditions, such operations would increase the exposure of infection to an adverse environment. In wet, warm weather the result would certainly be a more uniformly infected pasture. This might have considerable importance in view of the fact that cattle have been shown to be very efficient at selectively grazing the less infected parts of a sward [10].

Theoretically, rapid movement would assist the control of husk, as with worms in sheep, by reducing the rate of reinfection. Recent work by Michel and Mackenzie [11], however, suggests that the severity of infection may be related to the amount picked up over quite a short period, and not dependent on a gradual reinfective process.

Now rapid movement of cattle is usually associated with strip-grazing, and the latter is often characterized by a high degree of pasture utilization. In other words, strip grazing may obliterate a selective grazing pattern which has been shown to be of value in reducing the intake of infection from a given pasture.

Clean Pasture

This suggests that the main principle for control of husk should be the provision of relatively clean pasture [7]. To keep a continuous supply of such a pasture in front of the animal would seem to require a combination of movement and freedom of selection. This could be achieved by lenient strip-grazing of cattle, followed, perhaps, by sheep. The latter could improve utilization, prevent the patchiness associated with lenient grazing, destroy a significant number of lungworm larvae and leave an open sward, exposed to any adverse climatic conditions which might occur. The object would be to prevent the animal ever grazing highly infected pasture. Where the level of infection was getting too high, it might be possible to interpose a period of lucerne grazing. Lucerne would seem to be a promising crop for the control of husk by management, although little research has been carried out on this aspect.

Finally, it must be recognized that intensive stocking may be associated with a considerable degree of specialization. There is every reason to believe that the parasitological consequences of high stocking rates can be offset by improved grazing management, but specialization in one class of stock limits the flexibility of such management. Flexibility would be improved and the advantages of specialization might remain unimpaired if more than one specialized enterprise were integrated on one farm, allowing alternation of the pasture used for each.

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Cider Apple Growing Today

JOHN DUGGAN

National Agricultural Advisory Service, Hereford

THE MIXED FARM ORCHARD of the western counties of England is a familiar sight to any who pass that way. It was equally familiar to those who tilled the land several hundreds of years ago. At first, no doubt, it was the home paddock planted with fruit trees; it was near to the farmhouse and produced fruit for eating, cooking and for making cider. It also provided shade for the cattle and was a useful place in which to segregate the animals, or keep chickens, ducks and other small livestock needing daily attention.

This kind of orchard has passed through various economic patterns. At first, the varieties of apples and pears grown were very mixed and were either for use at home or for sale, but from about the beginning of this century farmers gradually found that dessert and cooking apples produced in this way sold less readily than those produced in bush orchards, which could be more easily managed and sprayed. Today it is becoming more and more clear that the farm orchard should be planted with cider apples or with perry pears. If a farmer is prepared to spray his trees regularly throughout the season he may with advantage plant some of the keeping varieties of cooking apples, but there seems little, if any place for dessert apples.

In the last hundred years many orchards were planted away from the farm buildings. In Hereford, most of these have been cider apple orchards. This trend is slowly increasing as more attention is being paid to the choice of site and soil to suit the trees rather than the convenience of the farmer. The present planting pattern seems to be first to "gap-up" spaces in existing mixed orchards with cider apple varieties, and then to plant out new orchards of cider apple trees. There will no doubt be some planting of cooking and dessert varieties of apples and also damsons, and this will often happen when a farmer sees a good, well-grown bundle of trees for sale at a market, and is tempted to buy on sight without much thought about how the trees will fit into his farming plan.

What is the Outlay?

Returns for the sale of cider apples have rarely been very high. Before the war £4 a ton was the price, but now it is about £12-£13 a ton delivered to the factory. It varies, of course, from year to year. Many orchards will not yield above 1-2 tons of fruit an acre, but an average of 5-6 tons an acre per year should be harvested from fully bearing orchards made up of the better cropping varieties. How long an orchard takes to reach its full cropping capacity depends largely upon the treatment the farmer gives it in the first 5 years. It used to be said that the period before cropping was 25 years, but if the farmer

makes full use of modern methods of orchard management, the orchard should be producing sufficient apples to pick up in 6-7 years, and a very useful crop at 12 years, rising to near maximum by 20 years. After this, the orchard may well have a useful life of 30-40 or even 50 years, depending upon how well it is looked after. On this basis, the sales of fruit alone may not justify planting the trees. True, the capital expenditure in planting an orchard in Hereford is not large, say 8s. 6d.-10s. 6d. for the tree and 6s. for a good stake, wire netting guard and a length of barbed wire, with an additional charge of 3s. a tree for setting out the orchard and for planting and staking. It is customary to plant 30-40 trees to the acre and, at 35 trees per acre, the cost would be about £31-£35 an acre. Because of the low returns, the three-fold practice has developed of cash sales of fruit, grazing for sheep and cattle, and shelter for cattle from heat and cold and for lambing in the spring. To this may well be added the "uncostable" item known as "convenience" when the orchard also serves as a home orchard near the farm buildings and is put to many uses.

Selection of Site

In Herefordshire few orchards planted 50-70 years ago were on poor soil or were badly sited. This cannot be said of those planted 20-30 years ago, but today, there seems to be a better approach to the problem. Most farmers are well aware of the need to select sites which are not subject to spring frosts, but they are not usually so knowledgeable in the selection of a suitable soil. Many ask for advice and are often surprised to find how shallow, or poorly drained are some of the fields. It is becoming better known that cider apple trees like a deep well-drained loamy soil. Soils with less than 18 in. of weathered material are unsuitable, and whilst cider apple trees will tolerate slightly impeded drainage, they will not flourish where there is waterlogging of the soil even for short periods. Generally, the heavier soils are preferable to the light sandy soils, provided soil aeration (or drainage) is adequate.

Choice of Varieties

From earliest times there has been a constant search for new and better varieties, a search which can be conveniently divided into three phases. First there was gradual improvement by raising new varieties locally; this was a slow process, and even when a better variety was produced, it was often a long time before it became widely known. The second phase came with a survey of existing orchards made by the Woolhope Naturalist Club in 1880 and also later with the selection and importation of the better-known varieties grown in France. Whilst all this was very useful, it was not until 1913-16 that trial plots were put down by Long Ashton Research Station in a number of counties to obtain a true comparison of varieties. These results were most useful, particularly those from the plots planted at Burghill, Hereford, from which

Mr. C. Savidge took careful cropping records for fifteen years. From these results and the observations of a number of people, the first list of Cider Apple Varieties recommended for planting was published in 1947.

Later, when cropping results were obtained from a number of trial plots of cider apples and bush trees, and more became known about varieties in the old list, a new list was needed. This has now been prepared and has been published in the April 1957 issue of *Agriculture*. During the preparation of this list it was agreed that a general recommendation could be given to only eight varieties, and that many varieties of good repute locally had not been grown widely in the cider apple-growing counties. This has led to the next phase, the planning and planting in a number of trial orchards in Somerset, Gloucester and Hereford of some fifty varieties of cider apples, about which more information is wanted. Twenty-five years will have gone before the full results of these trials become known, but much useful information may well be available in fifteen years' time.

Flowering Times and Pollination

Whilst the approximate flowering times of the main varieties have been known for a long time, they have only been accurately recorded recently. Even less was known about which varieties were self-fertile and which needed to be cross-pollinated; which produced good pollen and which did not. Since Mr. R. R. Williams has been at Long Ashton Research Station, he has investigated most of the well-known varieties and we now know which are triploids and which are diploids, which are self-fertile and which are not. This, together with accurate knowledge of flowering times, has provided much of the information needed for better planning of orchards.

Preparing the Plan

If the orchard is to be used for grazing it is obviously an advantage to plan to make the period when the cattle must be excluded for the sake of the fruit as short as possible. In the new list, varieties have now been grouped according to flowering times and harvesting periods. The latter have been divided into early, midseason, late midseason, and late harvesting periods, and an orchard may be planned so that the varieties chosen can fit into one of these four groups and so reduce the period when cattle must be excluded from the orchard.

Unlike dessert and culinary apples, it is not very important to keep varieties of cider apples separate at harvesting time, and a number of varieties may be grown in one orchard. A minimum of three should be planted for pollination, but the ideal is probably four, keeping each row of trees to one variety to facilitate picking up the fruit. Other arrangements can be made if special conditions prevail. For example,

if the site is likely to suffer from spring pests, late-flowering varieties, such as Stoke Red or Medaille d'Or should be chosen, or if it is very open to the wind, varieties subject to wind damage, such as Tremletts Bitter should be avoided.

Planting Distances

Many trees in apple orchards are planted too closely together, but this does not often occur with cider apples because of two opposing viewpoints: to get as many trees per acre as possible to produce fruit, and to provide enough light for the sward when the trees have reached their full size. Few people would plant more than 40 trees per acre or less than 30; a fair compromise is 35 trees per acre, which works out at 35 ft square and has the merit of being easy to remember. Some farmers plant on the square, and others on a triangle. The former gives a very straightforward plant which makes harvesting easy, whilst the latter is claimed to give more trees per acre—though this obviously depends upon planting distance—and more shelter and shade. The triangular plant is probably better for the trees but not so good for the grass, and so with both needs in mind, the square plant is to be favoured.

Rootstocks

For many years the nurseryman has used the seeds from the cider apples as a source of rootstock on which to graft his varieties. Latterly, the vegetatively propagated Crab C and M. XVI have been tried. No critical trials have been carried out to test these three stocks, but from observation there seems to be little to choose between them provided that a rigorous selection is made from the seedbed choosing only vigorous seedling rootstocks.

Tree Training

There are two stages here, first in the nursery and then in the field. Newer methods of training apple trees have been used now for a number of years, and branches breaking at the crotch of a tree should be a rarity today. The cider apple grower has been slow to take up these methods, but it is pleasing to find that in Hereford, most of the trees now planted have been well trained in the nursery. The delayed open centre shape is now predominant, and trees leaving the nurseries should have a clear stem of 6 ft 6 in., with a 1-year head consisting of a central leader and 2-4 primary branches arising at wide angles to the main stem.

Post-Planting Programme

Much care and attention is given to producing cider apple trees, to planning an orchard, choosing the varieties and planting the trees. It is a pity that more care is not taken after planting. Few farmers realize when planting a standard cider apple tree that it is a 5- or 6-year-old

tree. One or two years have usually been taken to produce the root-stock and a further four years to produce the top. It therefore deserves special care and attention after transplanting. Assuming it to be well planted and securely staked and guarded, there are three things each farmer should do for his trees. Firstly, see to manuring. Make sure the soil is not deficient in potash, and apply $\frac{1}{2}$-$\frac{3}{4}$ lb of sulphate of ammonia or "Nitro-Chalk" in February to each tree over a circle of radius 5 ft around the trunk. This should be repeated each year, increasing the quantity and the area over which it is spread. Secondly, provide a mulch around the tree using dung, straw or even old sacks. Of the three, straw is the longest lasting provided chickens do not scatter it. The mulch should be adequate and extend to 3 ft around the tree. The usual two forkfuls of dung thrown at the base of the tree is pitifully inadequate. Thirdly, see that the trees are correctly pruned for at least six years after planting. It does not seem to matter much whether the trees are pruned in the winter of planting or not, but they should be pruned for each of the succeeding five years and would be better for pruning each year until the tenth year. The need for attention to staking and guarding is obvious but often overlooked.

Perry Pears

Most orchards of perry pears are old, but as perry has become more popular as a drink lately, interest is being taken in planting perry pear orchards. Trees are scarce, and knowledge of varieties to plant is scanty, though much of what has been said about cider orchards applies to perry pear orchards. If the interest in perry grows, and if prices for the fruit increase, we may yet see more perry tree orchards planted. This would be very welcome; it would be sad to see the making of perry die out, and there is little to equal the sight of a full-grown perry pear orchard in full bloom or, with some varieties, in autumn colour.

Reviews and Abstracts

The Irrigation of Vegetables

A Review of the Present Stage of our Knowledge

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MODERN RESEARCH on irrigation may be said to have started with the work of Veihmeyer. He focused attention on certain basic facts concerning the moisture contained in soil, and laid the foundations of modern thinking on irrigation, although, ironically enough, few workers now accept Veihmeyer's own contribution to the subject.

Veihmeyer and Henrickson [1] gave a definition of field capacity which may be paraphrased as the maximum amount of water which can be held by a soil against free drainage. This quantity is a characteristic of the soil, and bears no relation to the plants growing in it. In general, heavy soils have a high field capacity, while sandy soils have a low field capacity. Addition of humus may increase field capacity to some extent; Russell [2] found that normal cultural practices had little effect on it but more recent work by Salter (unpublished) indicates that surface cultivation may increase field capacity even if only temporarily.

Briggs and Shantz [3] defined wilting coefficient, now usually called permanent wilting point, as "the soil moisture content at which all plants wilt and do not recover turgidity even when the atmosphere above them is saturated". Permanent wilting point may be loosely termed the soil moisture content at which plants are unable to take up water for growth. Again, this quantity is a soil characteristic, and all ordinary plants wilt at the same moisture status in a given soil.

The amount of soil moisture represented by the difference between field capacity and wilting point is called the available water. Veihmeyer's experiments appeared to show that water was equally available to plants at all soil moisture contents between field capacity and wilting point. Salter [4] has pointed out that one reason why Veihmeyer failed to find different availability at different moisture contents was because the moisture content at which he watered his plants was usually far short of field capacity. Salter's experiments showed a sharply increasing yield response with glasshouse tomatoes as the ruling soil moisture status approached close to field capacity.

Veihmeyer showed that as water is added to the surface of the soil, a saturated zone extends downwards, and that there is no extension of the wetted zone until all the soil above it has been saturated. Thus it is not possible by ordinary means to raise the moisture content of soil to any level other than field capacity. Reducing the amount of water added merely reduces the depth of the layer brought to field capacity (Fig. 1).

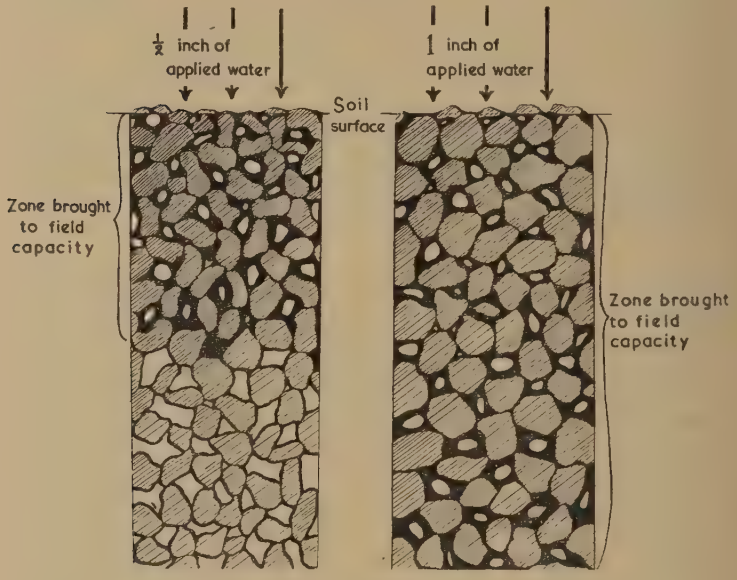
½ inch of applied water
1 inch of applied water
Soil surface
Zone brought to field capacity
Zone brought to field capacity

Fig. 1. The effect of reducing the amount of water applied to the surface of the soil is to reduce the depth of soil brought to field capacity.

If more water is added than the amount required to raise the whole profile to field capacity, the excess will drain away, and may leach out a proportion of the soluble material in the soil. Leaching is used exceptionally to remove harmful salts which have accumulated in the soil, e.g., in the winter flooding of glasshouses, but in the open, it should usually be avoided because of the danger of wasting plant nutrients.

Estimating Soil Moisture

The maximum amount of water which should be applied at any irrigation, therefore, depends upon the current soil moisture content and the field capacity. Field capacity may be determined once and for all either on soil samples, or on specially prepared field sites. On the other hand, frequent assessments of soil moisture content are necessary for day-to-day irrigation control. The most direct method is to measure the moisture content of soil samples in the laboratory, but this is time-consuming and obviously not suitable for use by growers.

Many workers have devised soil moisture meters which are intended to be placed in the field soil. Such instruments depend on the association of various physical properties of the soil with moisture content, e.g., electrical resistance, Bouyoucos and Mick [5]; electrical capacitance, Fletcher [6]; thermal conductivity, Shaw and Baver [7], de Vries [8]; the scattering of neutrons, or gamma rays, Belcher, Cuykendall and Sack [9]; and the absorption of water from porous weighable plugs, Davis and Slater [10]. In 1935 Rogers [11] introduced the tensiometer to this country and he has since used various patterns with considerable success. Salter [12] has controlled irrigation treatments of glasshouse tomatoes satisfactorily by means of tensiometers manufactured for use by growers. Winter (unpublished) has made comparative tests of soil moisture meters of many types, and he has concluded that no one instrument can yet be recommended for general use by growers.

Some other method of estimating current soil moisture, therefore, must be sought. As already mentioned, excess water drains through a saturated soil until field capacity is reached. Thereafter only an insignificant amount of drainage takes place, and the soil moisture content falls because water is evaporated from the soil surface, and is transpired through the plants growing in the soil (Fig. 2). The potential rate of water loss by evapo-transpiration can be calculated from measurements of weather factors. Thornthwaite [13] uses the mean daily temperature as the only measured factor, but although his method is widely used, large errors are apparent at certain seasons. In Penman's method [14] measurements of duration of sunshine, mean air temperature and humidity, and run-of-wind are used to estimate the potential evaporation from an open water surface. This figure may be converted to potential evapo-transpiration from the soil by multiplying by empirically determined constants. In its usual form, Penman's formula assumes that the soil is covered with a uniform green crop and that the evapo-transpiration is not limited by water supply to the crop.

Stanhill [15], at Wellesbourne, is testing and developing the formula for use when the crop cover is not complete. With intensive market gardening, he has found that the average crop cover between April and September is only 15 per cent of the soil area. His daily Penman-type estimates agree well with the measured evaporation from an open water surface, and with measured evapo-transpiration from lysimeters and weighable soil cores bearing a grass crop.

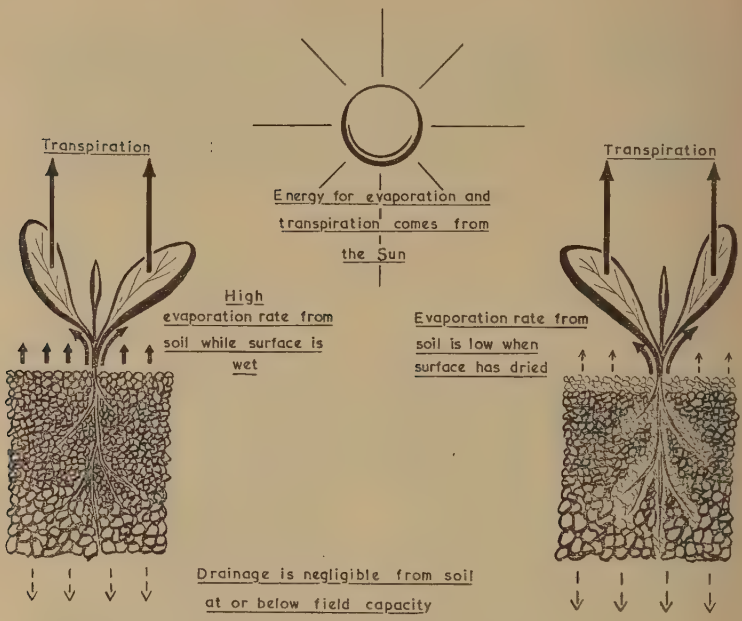
Transpiration
Energy for evaporation and transpiration comes from the Sun
Transpiration
High evaporation rate from soil while surface is wet
Evaporation rate from soil is low when surface has dried
Drainage is negligible from soil at or below field capacity

Fig. 2. The manner in which water is lost from the soil.

The Penman formula is of great value for irrigation research and for commercial irrigation. The result is obtained in units, namely inches of rainfall, which are immediately intelligible to the grower. The method requires regular observations from a weather station near the site to be irrigated, and while the prospect of the necessary calculation might tend to deter some potential users, it should be noted that information on local current soil moisture deficit already calculated on this formula is freely available to growers from either the Meteorological Office or from N.A.A.S. officers.

Stanhill and Winter [16] have devised an instrument which is intended to be placed in the crop to be irrigated. Rain and irrigation water are collected and stored in a reservoir which is connected to a ceramic evaporation surface exposed to the same weather as the crop; when the instrument is correctly adjusted, the current level of the water in the receiver corresponds with the soil moisture status of the field. Present work is aimed at evolving a design which will be suitable for use by growers.

Thus various ways and means are available for determining how much water may be added to a soil without fear of drainage or leaching. Before rational irrigation can be carried out, however, it is also necessary to

know how often to irrigate, and whether it is necessary at each application to restore the whole depth of the soil to field capacity. The answer to both questions depends upon the plants growing in the soil.

Soil Moisture Regimes

The movement of water by capillarity is relatively small (Staple and Lehane [17]), and may be discounted from the point of view of keeping a crop growing at maximum rate. It is only necessary to apply enough water to restore to field capacity that depth of soil which the crop roots have penetrated. If more than this quantity is applied, there will be a risk of washing nutrients down to levels beyond the reach of the roots. If less is applied, the lowest roots will receive none at all.

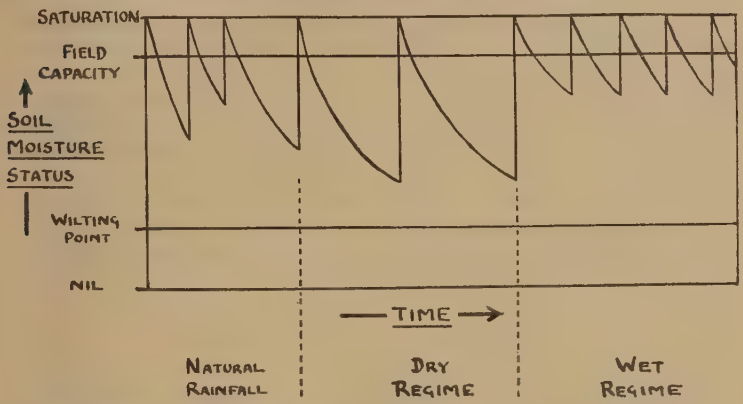

Fig. 3. The regime concept; fluctuations in soil moisture status typical of natural conditions, a dry regime, and a wet regime.

Fig. 3 shows typical fluctuations in soil moisture content which can occur under a crop over a period of time. If there are long intervals between irrigations (or rain showers), the soil moisture environment of the roots will alternate between being very wet and very dry, and a comparatively large amount of water will be required to restore the soil to field capacity at each application. If there are short intervals between irrigations, the soil moisture environment will remain continuously wet, and only small quantities of water will be required at each irrigation to restore the soil to field capacity. The first system requires large quantities of water at infrequent intervals, and is often referred to as a dry regime; the second system demands frequent light applications of water, and constitutes a wet regime. According to the usual definition, the maintenance of a given regime implies that no water is added to the soil until a certain degree of dryness has been reached, and at this point the whole depth of the soil is then restored to field capacity.

Under glass, where there is no interference from rain, Salter [12] found that the maximum yield of tomatoes was obtained by using a wet regime in which the soil moisture tension was never allowed to fall below 7 cm. of mercury. On the other hand, Hudson and Majmudar [18], using a similar technique, found that the yield of lettuce was as good in a dry regime as in a wet one. Stanhill [19] obtained his highest yield of turnips by imposing a wet regime. His experiments were conducted in the open, but mobile covers were used to keep rain off the plots, and the watering was regulated by means of Penman-type calculations, whereas Salter, Hudson and Majmudar used tensiometers.

The Limiting Deficit Approach

Under field conditions, where rain may interfere with the strict application of the regime concept, many workers have used the limiting deficit approach. Here, the soil moisture deficit, usually calculated from meteorological data, is allowed to fluctuate naturally until a previously decided limiting deficit is reached. Sufficient water is then applied to return the deficit to nil (in other words to restore the soil to field capacity). The limiting deficit decided upon may be the same throughout the life of the plants, or it may be increased during the summer months, partly with the object of keeping practicable time intervals between successive irrigations. Both the regime system and the limiting deficit system are greatly facilitated if the soil is brought to field capacity before operations commence.

Irrigation Needs of the Plant

In practice, it is most unlikely that the average grower will have sufficient equipment, water or labour available to maintain the desired soil moisture status for every one of his crops throughout its life. At Wellesbourne, investigations are being carried out to ascertain at which stages of growth each of the main vegetable crops are most susceptible to periods of drought or periods of heavy rain, as reflected in the yield and quality of the produce. For example, Stanhill has found that the yield and quality of bunching turnips was unaffected by dry conditions during growth, provided that adequate moisture was available at germination and during the last three weeks before harvest [20]. When similar information for each crop is available, a grower will be in a better position to decide on the order of priorities for irrigating his crops during a period of drought, according to the effects on quality and yield.

Available Water

It must be emphasized that different soils contain different amounts of available water. Thus a deficit of, for example, one inch calculated from meteorological data, may represent a loss of half the available water in the top foot of one soil, but three-quarters of the available water in

another soil. Plants growing in these two soils would be subjected to differing soil moisture stresses, although the soil moisture deficit were the same. A further complication to be taken into consideration is the difference in the depth of rooting of plants even on one soil type. With a shallow-rooted crop, a soil moisture deficit of one inch may mean that all the available water in the root zone has been expended, and the plants may be wilting. With a deep-rooted crop, on the other hand, the same deficit may correspond to a very small proportion of the available water, and the plants will not be subjected to a severe moisture stress.

Effects on Plant Characteristics

An important aspect of irrigation is the effect of soil moisture conditions on the characteristics of the plant. Abundant soil moisture often causes an increase in the proportion of foliage to other growth; the crop "runs to leaf". This has been demonstrated at Wellesbourne with turnips, carrots, cauliflowers, marrows, radishes, and salad onions. The increase in leafiness may or may not be accompanied by a net increase in yield of marketable produce, and in any event, the extra trash may prove an embarrassment during harvesting operations. Soil moisture conditions also influence the conformation of the root system of some vegetables. Salter has found that the roots of tomatoes and cauliflowers remain near the surface in a wet regime but extend deeper into the soil when a dry regime is imposed [12 and 21]. Stanhill reports similar results with turnips [19].

Comparatively few experiments have included measurements of the effect of soil moisture status on the chemical composition, flavour and keeping quality of the produce. Tradition has it that irrigated produce is "watery"; the Wellesbourne tasting panel found heavily irrigated turnips watery and mild flavoured; on the other hand it found carrots grown under a wet regime to be sweeter and better-flavoured than those grown under dry conditions, Stanhill [22].

Both Salter [21] working with cauliflowers, and Winter [23] with peas, found that a dry regime caused these crops to mature earlier.

It is not proposed to deal here with the merits of different types of equipment for applying the water to the soil. Bean and Wells [24] have shown that variation in the drop size of water sprayed on the soil can affect the degree of damage to the surface tilth, but experiments at Wellesbourne to determine the effect of capping on crop growth have produced conflicting results. Other experiments now in progress show that the effect of water applied in furrows may be different from the effect of the same amount of water sprinkled on the crop. Not only the method of application, but also the drop size and the rate of application may affect different crops in different ways, but very few experiments on this subject have yet been reported.

Our knowledge of methods of assessing soil moisture status and the maximum desirable water application is comparatively well advanced, but our knowledge of the soil moisture requirements of the plants

themselves has not increased at the same rate. This is undoubtedly because of the complexities of the subject, and the need for determining the requirements of every crop separately. There is no "best" irrigation treatment applicable to all crops, and from the point of view of the commercial grower, it would be most useful to know which growth stages of the various crops may be left unwatered in time of drought, and which crops must have abundant water at some critical stage in order to avoid reduction in either yield or quality.

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Protein Digestibility and Utilization in the Ruminant

A series of papers has just appeared which reports the derivation of a general relationship between the percentage of crude protein in the dry matter of herbage, or of a mixture of foods (such as herbage supplemented with urea, silage and concentrates), and the percentage digestibility of this protein by the ruminant [1]. The same type of curve was found to fit data obtained from experiments reported from East Africa, England, India, Western Europe and the U.S.A., the significance in each case being more than 1,000 to 1. This was also true when applied to results from Australia, New Zealand and South Africa. Accordingly, a general equation from 597 records representing all areas was calculated:

$$y = 69.7 \log x - 13.9$$

(where y = percentage digestibility of the protein,
and x = percentage of crude protein in herbage dry matter)

The following excerpt shows the close agreement between the results calculated from the regional equations and from the general equation:

Percentage of Crude Protein in Herbage	Percentage Digestibility of Protein				
	East Africa	England and India	Western Europe	U.S.A.	Combined Data (597 results)
9	53.6	53.1	51.3	53.8	52.6
13	65.2	64.3	62.0	64.6	63.8
17	73.6	72.5	69.8	72.5	71.8

Similar examination of mixed feed records gave the following:

Percentage of Crude Protein in Mixed Feeds	Percentage Digestibility of Protein		
	East Africa	England, India South Africa, Puerto Rico	Combined Data (149 results)
9	50.3	51.5	50.5
13	62.6	62.6	62.3
17	71.6	70.7	70.9

The general equation for mixed feeds was $y = 73.7 \log x - 19.8$. When the two main equations were combined they gave an overall general equation:

$$y = 70.3 \log x - 14.9, \text{ or, more simply, } y = 70 \log x - 15$$

By these the digestibility of the protein in herbage or mixed feeds in the examples already taken would be:

Percentage Crude Protein	Percentage Digestibility (*equation as derived*)	Percentage Digestibility (*equation as simplified*)
9	52.2	51.8
13	63.4	63.0
17	71.6	71.1

It is too early to assess the significance of this newly-reported work but, while application of the general formula may give digestibilities which are broadly correct, there may not be such close agreement in particular instances. Thus, Dodsworth [2] has found that with mixed feeds, the methods and systems of feeding may to some extent influence complementary values. He found that when sheep were given fodder beet in the morning and silage at night, the actual digestibility of the crude protein averaged 51.6, compared with a calculated expected value (based on the digestibility of each food when fed alone twice daily) of 57.9; the difference was significant at the 1 per cent level. However, when the beet and silage were given together morning and night, the digestibility of the mixture was 59.2, a figure not significantly different from the expected one. Dodsworth comments that the results probably reflect the need for carbohydrate to be available simultaneously if the rumen micro-organisms are to be stimulated to work on protein.

This point has been taken up by Duckworth [3], who in his review mentions that utilization depends primarily upon the type of nitrogenous material *and* the type of carbohydrate in the ration. The proteins of herbage and of groundnut meal are readily converted to ammonia while those of maize products are practically unchanged. The special value of maize as a protection against low s-n-f due to a deficiency of milk protein is thus explained. The maize contributes little ammonia to the ruminal contents, and by providing plenty of starch it ensures that any ammonia from the breakdown of susceptible protein will be re-synthesized to microbial protein with the optimum efficiency. Thus, the maximum possible amount of true protein will pass to the abomasum and intestines for digestion into the utilizable amino-acids from which milk protein (and "maintenance" or body protein) is made.

How Valuable are Generalizations?

A consideration of this kind makes one question the value of generalizations such as the digestibility relationship referred to in [1]. Even if it is arithmetically true, it can only record the *disappearance* of some of the nitrogenous compounds of the food, but it cannot trace whether these have been finally absorbed as efficient amino-acids or as ammonia.

McDonald has shown [4] that only a very small fraction of the ammonia absorbed from the rumen is returned there in the form of urea via the saliva, and this fraction will merely become ammonia again and fare no better than before in a continuing lack of suitable carbohydrate. A recent report [5] reveals that when cows are grazing young spring grass, the concentration of ammonia in the rumen may remain steady for eight hours at a value twice as high as the peak reached (and maintained for a short time only) after a meal of hay and dairy concentrates. The addition of a starchy food can greatly reduce the ammonia concentration, and since ammonia may be a prime cause of hypomagnesaemia (grass staggers) in grazing cattle, the value of cereal supplements for spring and autumn grazing is evident.

Further Studies

Other work is reported from the Rowett Institute [6 and 7]. It arose in the first instance from the unexpected failure of the milk protein, casein, to benefit ewes which had been kept on a poor plane of nutrition and were about to lamb. In view of McDonald's findings it was suspected that microbial destruction was the reason for the failure, and this was verified by the improved result obtained when the casein was introduced directly into the duodenum. Also, if the casein were subjected to a toughening procedure involving heat treatment, there was less ammonia production in the rumen [6a]. A point of some interest was observed in the second paper of the series [6b]. This was that herring meal made by the usual heat process was more effective than casein in the production of lamb. The meat was not tainted by the herring meal and the use of formalin to preserve the herring before processing had no harmful effect. This interest was heightened by the further finding [6c] that groundnut meal was very easily degraded to ammonia whereas maize was only slightly affected, herring meal being intermediate.

Further work [7] on the comparative value of herring meal and groundnut meal for milk production again indicates the superiority of the former. It may be that further investigation on these lines will support the view held in some quarters that a small proportion of fishmeal should be included in dairy rations. Claims have been made that s-n-f and fertility have both benefited from such inclusion.

It seems to be clear that we can no longer afford to think of the protein and carbohydrate of the ruminant's diet as things apart: the quantity and quality of the latter affect the former so markedly. In particular, it would seem that home-grown winter foods such as hay and silage must be closely scrutinized, and lack of readily available energy made up by suitable carbohydrate concentrates. The ease with which the nitrogenous compounds in silage are degraded to ammonia [8] should be a warning that starch is needed to "stiffen up" such a diet.

This article has been confined to protein as it affects ruminants, but there are excellent reviews by Duckworth in which he deals with both the ruminant and non-ruminant and with energy aspects [3a and b, 9].

Although the loss of protein value by microbial action is a minor matter in the non-ruminant, other factors assume greater importance. For a discussion of these the reader must refer to the articles of which not the least helpful part is an introduction that explains clearly the measurement of nutritional value [3a]. From the final paper [9] the following information can be deduced for the year 1955:

Total Protein Supplies in the United Kingdom (imported plus home-produced)

Animal Protein			Vegetable Protein		
	1,000 *tons*	*per cent*		1,000 *tons*	*per cent*
White fish meals .	113	37.0	Cottonseed meal .	476	30.7
Herring meals . .	68	22.3	Groundnut meal .	385	24.8
Whale meals . .	31	10.1	Soyabean meal .	246	15.8
Meat meals . .	93	30.6	Palm Kernel meal .	184	11.9
			Others . . .	260	16.8
TOTAL . .	305	100.0	TOTAL . .	1551	100.0

Useful comments are made on the special features of the various protein concentrates.

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S.M.B.

Dairy Husbandry

Grass and the Milking Cow

While grass is by far the most important and often the cheapest source of nutrients for the dairy cow in Britain, little precise information on the quantity and quality of grass consumed by the dairy cow has, in the past, been available. Recently, however, the subject has received more attention. This has sometimes taken the form of the traditional type of experiment where grass is sampled before and after the cow grazes off the herbage, and an assessment of the quantity and composition of grass consumed is obtained by difference. More recently, techniques involving the use of "markers" such as chromic oxide or chromogens occurring naturally in the herbage have been added to, or assessed in the diet, and their concentration in the dung used to determine total nutrient intake and digestibility.

Using sixteen individually grazed milking cows at Shinfield (C. P. COX, A. S. FOOT, Z. D. HOSKING, C. LINE and S. J. ROWLAND, *J. Brit. Grassl. Soc.*, 1956, **11,** 107) the mean dry matter intake on an all-grass diet was found to be 23.7 lb per day per 1,000 lb liveweight. This rate of consumption compares very closely with that of 23.0 lb per day per 1,000 lb liveweight obtained at the Hannah Research Institute (D. S. MACLUSKY, *Proc. Brit. Soc. Anim. Prod.*, 1955, 45). In the work at Shinfield there was evidence that generally the bigger the cow, the more grass it ate, but the individuality of the cow is of considerable significance both as regards quantity and composition of herbage consumed.

While the intake of grass by cows on carefully controlled experiments is of interest, it must be borne in mind that in practice the milking cow is offered a great range in quantity and quality of sward, and observation of grazing behaviour in a number of investigations indicates that the particular grazing circumstances may have an important effect on the amount and composition of grass consumed. Some of the best evidence on this has been obtained by Hancock and his co-workers in New Zealand (e.g., J. HANCOCK, *J. Agric. Sci.*, 1954, **44,** 420; J. HANCOCK and C. P. MCMEEKAN, *J. Agric. Sci.*, 1954, **45,** 96) and while their data indicated that dairy cows "attempt to maintain a stable production in

the face of adverse pasture conditions by increasing their feeding time", a number of cases have been cited indicating that there is a clear limit to which most cows will go in order to acquire their nutrient requirements on very poor-quality swards.

Apart from the more obvious deterioration of swards due to their high fibre content because of over-maturity, unsuitable grasses or invasion of weeds, there is accumulating evidence concerning the more subtle qualities of grass for the milking cow. This has been referred to by Paterson (Rex Paterson, *J. Brit. Grassl. Soc.*, 1956, **11,** 93) on a herd basis, particularly so far as different seasons of the year are concerned. Comparisons of four grasses for milking cows (D. M. Seath, C. A. Lassiter, J. W. Rust, M. Cole and G. M. Bastin, *J. Dairy Sci.*, 1956, **39,** 574; C. A. Lassiter, D. M. Seath, J. W. Woodruff, J. A. Taylor, and J. W. Rust *J. Dairy Sci.*, 1956, **39,** 581) in Kentucky suggests that the variation in the milk-producing value of different grasses may sometimes largely be due to variations in amount of dry matter consumed rather than to differences in digestibility. Comparisons of meadow fescue, perennial ryegrass and cocksfoot, each grown with S.100 white clover at Shinfield (*N.I.R.D. Ann. Rpt.*, 1954, 35; and *N.I.R.D. Ann. Rpt.*, 1955, 35) have indicated a slight superiority of meadow fescue over the other two grasses so far as cow days or milk yield per acre is concerned. In this investigation, as in any other where the grazing animal is concerned, it is impossible to differentiate between the inherent nutritional value of the individual grasses and their changing status in the sward. For example, in the comparison at Shinfield, the enhanced value of the meadow fescue may have been partly due to its less vigorous competition with the clover with which all three grasses were sown.

Milk Quality

Two recent publications have helped to clarify the significance of some of the factors affecting the butter-fat and solids-not-fat content of milk. The Milk Marketing Board ("Variations in the composition of milk from individual animals and herds". Milk Marketing Board, 1956) have examined the results of an investigation of the composition of the milk of the cows in nine herds over a period of five years.

The data illustrate very clearly that while factors such as season of the year, stage of lactation, age of cow, will affect the composition of milk fairly consistently, if one is considering large groups of cows in which one factor at a time is investigated, their combined effect on individual herd bulk milk may be very complex and varies greatly from herd to herd. Thus, for example, the combined data from all nine herds indicated that on average the fat percentage is lowest in May, being only a little over 3.3 per cent, and was highest in October at 3.7 per cent; the upward trend in summer and the downward trend in winter was fairly regular and consistent. On the other hand, the changes in fat

percentage of herd milk of the individual herd were often quite different from, and much less consistent than, the mean for the nine herds. In the different herds the highest fat percentage for the bulk milk might occur in any month from July to February, while the lowest level was usually found in April, May or June.

The M.M.B. investigation also showed that there was a wide range in the quality of milk among individual cows in all herds. Thus, in each of the nine herds there were cows with lactation fat percentages of below 3 per cent and others with lactations of over 4.2 per cent fat. Similarly, in each herd there were some cows whose lactation average s-n-f percentages were below 8.2 per cent and others with over 9.2 per cent. This wide range in milk quality in the individual cows within a herd and the great variability in the factors such as stage of lactation, age of cow, season of the year, system of feeding in any one herd at a particular time emphasize the difficulty of dealing with a herd bulk milk problem on general principles, and point to a need to investigate each case as a separate complex problem.

The Milk Marketing Board survey is of particular interest in that it provides further evidence of the marked fall in s-n-f as the age of the cow advances; this was noticeable in all herds. The data indicated that a decrease of 0.1 per cent may be expected in the s-n-f level from the first to the second and a further similar fall from the second to the third lactation. The decrease is liable to be smaller in subsequent lactations but often continues to the fifth lactation, and it is evident that the proportion of old cows in the herd may be of considerable importance where the s-n-f content of the herd milk is near the presumptive legal standard.

Other work on milk quality reported recently concerns Ayrshire cattle in Scotland (R. WAITE, J. C. D. WHITE and ALAN ROBERTSON. *J. Dairy Res.*, 1956, **23,** 65; ALAN ROBERTSON, R. WAITE and J. C. D. WHITE. *J. Dairy Res.*, 1956, **23,** 82), in which 814 animals over a period of over three years were involved. The work is of particular interest since the effect of stage of lactation on the yield and composition of milk was studied after the effect of season of the year had been eliminated, while, conversely, the effect of season was investigated with the influence of stage of lactation eliminated. The work covers not only changes in fat and s-n-f, but also changes in crude protein, casein and lactose independently. The changes in milk quality with season followed the well-known general pattern, with the fat percentage falling to its lowest level in June almost concurrently with the highest level of s-n-f. It was, however, noted that whereas the s-n-f reached its highest level at this time, the *total* solids reached the highest percentage in October. Again the drop in s-n-f with age was more rapid from the first to the second and second to third lactation, with a tendency to diminish only very slowly with later lactations.

A.S.F.

Farm Management

Grain Drying and Storage

The combine-harvester is now well established for harvesting corn in this country. Indeed, as it can easily reduce costs by £4 per acre, this is hardly surprising. The widespread use of this machine does, however, raise the problem of who is to dry and store grain after harvest. At first sight, it would seem that large-scale organization of grain drying and storage must be the most economical. In fact, closer study shows that the farmer can probably compete on fairly equal terms with any other agency. Quite apart from costs, grain storage gives the farmer a stronger bargaining position and allows him to gain from seasonal increases in price. In spite of the heavy capital costs, a large number of farmers have installed grain-handling equipment or are considering the possibility of doing so in future.

It was to provide a guide to the latter that a detailed study has been made by J. S. Nix [1]. Three types of drier—continuous driers, ventilated bins and sack driers—are considered in turn. Figures of capital costs and running expenses are presented together with a discussion of the advantages and disadvantages of each type. The following table gives the estimated drying costs per ton (removing 4 per cent moisture) at 1956 cost levels for a wide range of throughputs:

Average Annual Throughput (tons)	10	20	50	100	200	400
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Continuous Drier, 2½ tons/hr .	30 8	15 7	6 6	3 6	1 16	1 1
Continuous Drier, 1 ton/hr .	17 4	8 17	3 17	2 3	1 7	18
Ventilated Bin, 200-ton plant (electric)	9 9	4 19	2 5	1 7	18	—
Ventilated Bin, 100-ton plant (electric)	6 17	3 13	1 15	1 2	—	—
Sack Drier 60-hole, oil-fired .	6 19	3 12	1 13	19	13	—
Sack Drier, 20-hole electric .	2 13	1 13	1 1	—	—	—

Assuming a typical contract charge for drying of 35s. per ton plus 10s. for transport, the minimum throughputs necessary before each type of drier becomes profitable were:

Continuous Drier, 2½ tons/hr	155 tons per year
Continuous Drier, 1 ton/hr	95 „ „ „
Ventilated Bin (200-ton plant)	50 „ „ „
Ventilated Bin (100-ton plant)	35 „ „ „
Sack Drier, 60-hole, oil-fired	35 „ „ „
Sack Drier, 20-hole, electric	12 „ „ „

There are, of course, many other factors to be taken into account besides costs. Farming circumstances vary so greatly that each type of drier has its place on one farm or another. Similarly, the various methods of grain storage which are available are all useful on different types of

farms. The report compares the costs of bulk storage with ventilated bin storage, contract storage and sack storage, and lists the advantages and disadvantages of each system.

The advisory officer will find the technical and economic information in this report invaluable when discussing with farmers the most appropriate type of drying and/or storage plant to suit the circumstances of each particular farm. The report can also be recommended to farmers who are considering the purchase of grain drying and storage equipment.

Milling and Mixing on the Farm

The saving in the cost of feedingstuffs obtained by milling and mixing on the farm has been estimated at from £3 to £6 per ton. An article in Farm Mechanization [2] describes the layout, cost and throughput of several alternative milling and mixing plants installed on farms in Somerset. The total cost of the equipment varied from £300 to £580—an outlay which is readily recouped on farms using large quantities of concentrates for livestock. Although much briefer than the grain drying report referred to above, there is sufficient information to demonstrate various systems of food preparation.

Sugar Beet

Further reports on the costs and returns from growing sugar beet again emphasize the importance of producing high yields if reasonable profits are to be obtained. A study of sugar beet growing in Yorkshire in 1955 [3] shows that the average costs per acre were similar (£57) in the Wolds and Holderness and in the Vale of York. Furthermore, the average costs per acre were the same in the previous year although the yields were 3 tons 13 cwt lower than in 1955. Since the sugar content was also 2 per cent lower in 1954, there were average losses of £3 18s. 6d. and £12 18s. 6d. per acre on the Vale of York and the Wolds and Holderness farms respectively, whereas there were profit margins of £25 12s. and £17 3s. per acre respectively in 1955. As the costs were obtained from an almost identical sample of farms in the two years, the substantial difference in the profit margins can be attributed mainly to the effects on the crop of the adverse weather conditions in 1954. It is because variations of this magnitude are possible in the returns from year to year that partial budgeting cannot be used to forecast accurately the actual profit margins from an enterprise in any one year. Partial budgets can, however, be used to measure the likely average margin over a period of years using yield figures which can reasonably be expected in an individual locality. (For instance, in both 1954 and 1955, the average yield per acre was 1½ tons greater on the Vale of York farms than on the Wolds and Holderness farms.) The main purpose of partial budgeting is not to obtain absolute measures of costs, returns and margins, but to compare the relative costs and/or margins obtained from different enterprises and processes. In budgeting for an increase in either the potato or the

sugar beet acreage, for example, it is often reasonable to assume that the weather would have a similar effect on both potato and sugar beet yields in any year, and although the budgets may not be correct in absolute terms, they may still accurately reflect the relative margins to be obtained from each crop.

On the Vale of York farms 57.3 per cent of the beet acreage was harvested by machine, whereas on the Wolds and in Holderness (where often only the regular farm staff was available for harvesting the beet) the percentage was 84.6. Harvesting by machine on the costed farms was much cheaper than pulling, knocking and topping by hand.

A similar conclusion on the advantages of mechanical harvesting is reached in a study of sugar beet growing in Nottingham and Lincolnshire in 1955 [4]. After presenting a table showing the declining costs per acre of a mechanical harvester as the acreage increases, the author states: "If beet is at present harvested by hand, a separate topper and lifter would be cheaper on 5 acres or over and a complete harvester on 11 acres or over. If a separate topper and lifter is at present used, a complete harvester would be cheaper on 36 acres or more."

In this survey, some 70 per cent of the sugar beet tops were either fed *in situ* or carted for feeding. In view of the high feeding value of sugar beet tops (they were valued at £3 10s. and £3 per acre in the two reports discussed here), the farmers growing the remaining 30 per cent of the beet acreage were probably foregoing considerable profits by failing to utilize such a valuable by-product. In a year when yields are low, utilizing beet tops may mean the difference between a profit and a loss from the crop.

Fat Sheep Production

An interim report [5] on fat sheep production from grass in the North-West for the year 1954-5 quotes an average net margin of £1 2s. 10d. per fat lamb, with an average dressed carcass weight of 44.8 lb. Flocks of long wool breeds had a higher lambing ratio and a better net margin per acre, despite lower receipts per lamb due to later selling.

Interesting figures are given of the relative profitability of early and late lamb production. Higher prices for fat lambs in the early part of the season were offset by the cost of additional feeding (partly due to the exceptionally slow growth of some pastures in 1955) and by the lower lambing ratio found in the early-lambing flocks. A loss of 1s. 11d. per ewe is shown for flocks where the average date of fat lamb sales was in June. On the other hand, flocks from which most lambs were sold off during the first fortnight of August show a profit margin of £2 11s. 11d. per ewe. Later lamb sales tended to be rather less profitable because of the higher weight of lambs and the longer feeding period. The author concludes that "these results do not prove, of course, that late selling is always more profitable than early selling. Under the prices ruling

during 1955 any lamb which reached, say, 38 lb deadweight in May was probably worth selling rather than keeping. However, the figures seem to indicate that the *intentional* policy of *producing* early lambs (as distinct from the early selling of lambs which reached a suitable weight) involved so much expense in winter feeding of ewes that it would only have been justified in flocks with a high lambing ratio".

A more ambitious survey of sheep production in the North and East Ridings of Yorkshire has been reported by I. G. Simpson [6] of Leeds University. He gives general aspects of the integration of sheep into the farm economy on lowland farms and detailed costs of the enterprise. Unfortunately, however, the cost investigation relates to 1951/52 and 1952/53, since when the costs of, and—to a greater extent—the returns from, sheep production have changed considerably. As a result, a number of the conclusions are not relevant to present farming conditions. Furthermore, because many sheep flocks are essentially scavengers, it is difficult to assess their true value in the economy of a farm by using conventional costing procedures. Nevertheless, the report contains physical information of feed, labour and other requirements which could be useful guides when calculating budgets for lowland sheep production.

Milk Production Assessment

Weaknesses in the organization of a farm are often found by analysing the accounts. A detailed analysis of the costs and returns from milk production can be made with the aid of *The Dairy Herd Work Book* [7] recently issued by the Farm Economics Branch of Cambridge University. This book consists of a number of sheets for recording the quantities of feed fed, labour employed on the cows, etc., together with simple instructions for the calculation of useful "yardsticks" to gauge efficiency of production. The purpose of the work book is summarized in the preface:

> If a farmer grows cash crops, the success of his efforts are obvious even to casual inspection. If yields are high, the crops are likely to be profitable. If they are low, they are almost certainly unprofitable. In milk production, the position is less simple. Cases frequently occur when an apparently well managed herd giving high yields is, in fact, losing money. The reasons might, for example, be the excessive use of high cost foods or the inefficient use of labour. Such causes are not immediately apparent and may only be traced by the use of systematic records.

Although this publication has its weak points (for example, no method of estimating the cost of production of home-grown feeds is suggested), it should assist farmers in tracing the causes of relatively low profits from milk production.

Winter or Summer Milk Production?

Beynon and Langley [8 and 9] have calculated the relative profits from winter and summer milk production in the South-West. Because of the number of variables involved, it is difficult to draw valid conclusions,

but the authors have shown how a farmer can set about assessing the most profitable system in his own case. With the input/output ratios which they assumed, a herd of 20 cows calving in October would earn a margin ranging from £117 to £304 more than a herd of 20 April calvers. The higher figure relates to farms feeding both kale and silage, and the lower figure to those not feeding either. Even with a reduction of 3d. per gal in the price of winter milk and an increase of £5 or £10 per ton for dairy cake, there would still be a margin of £206-£210 in favour of winter milk if both kale and silage were fed. But such changes in input/output prices would make summer milk production more profitable if the production ration during the winter months consisted entirely of concentrates.

Does Heifer Rearing Pay?

Further studies have been made on the most profitable methods of rearing heifers for dairy replacements. Bennett Jones [10] compared the costs of rearing autumn-born calves to 26 weeks of age under several systems of management: whole milk only; some whole milk and some milk substitute; and milk substitute only. Using whole milk only the feeding costs were about £24 per calf, but these costs declined to only £13 per calf when milk substitutes were used entirely after the first few days of the calf's life. With spring-born calves about £8 10s. was saved by using milk substitutes. In such a short-term study it was, of course, impossible to estimate the difference in value (if any) of fully-grown heifers reared under the different systems.

Holt and Gardner [11] at Manchester have compared the costs of rearing heifers with the cost of purchased heifers and calculate that, under average conditions and at 1954-5 prices, a farm of 120 acres could carry either 63 milking cows or 42 cows and followers. Net income from the latter system would be £135 per annum lower than from the former. However, they reached the rather negative conclusion that "having regard to the different levels of expenditure, the difference in net incomes resulting from the two methods of herd replacement, under average conditions and at 1954-5 prices, is insufficient of itself to determine which policy should be followed". In arriving at this conclusion milk cost data for 1954-5 (a particularly poor year in the North-West) were used, and the cost of heifers was estimated at £62. In a similar study from Cambridge in 1954-5 [12], the cost of rearing heifers was estimated at £84. If this figure (together with more normal milk cost data) is used to calculate the relative profits from milking cows or rearing young stock, then the financial advantages of purchasing rather than rearing dairy replacements would have been considerably greater. In fact, the Cambridge study suggested that it was more profitable to buy rather than rear replacements, unless the purchase price of down-calving heifers reached more than £113 per heifer.

Labour Requirements

Factual information about the use of manual, horse and tractor labour on farms in Yorkshire has been published by Leeds University [13]. The types of work undertaken on farms are divided into three categories: work on crops, work on stock and "other work"—mainly of an overhead nature. For crops, labour requirements for each operation and the seasonal pattern of requirements are presented. For livestock enterprises, details are given of the labour requirements under various systems and conditions of management. Almost one-fifth of the total labour time during the year, on 49 farms from which detailed records were available, was spent on miscellaneous work such as carting and spreading farmyard manure, hedging and ditching, and general repairs and maintenance. The information in this report is of considerable value both in assessing the relative profitability of alternative enterprises and in estimating the seasonal pattern of labour requirements for the farm as a whole.

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Machinery

Barn Hay Drying in the U.S.A. and Sweden

Barn drying on a commercial scale began in the U.S.A. and was based first on cold-air ventilation of the crop in the long state, in the lofts of typical two-storey barns. This system of conservation did not, however, make much headway until the use of supplemental heat where necessary was facilitated by the development of portable oil-fired drying units. These are usually of the heat-exchanger type, though some work on the direct heating system. A fairly comprehensive account of modern practice is contained in U.S.D.A. Bulletin No. 2028 [1]. The process is claimed to be applicable to any area where it is possible to reduce moisture content of the crop to 50 per cent by field drying within a reasonably short time. The Bulletin places considerable emphasis on the value of heat when atmospheric conditions are adverse. In addition to describing typical American equipment for barn drying, a brief account is given of methods employed to enable portable units to dry baled hay out in the field. A slatted staging is normally used to help to construct a uniform tunnel of bales, and a tarpaulin is placed over the top and sides, so that the air leaving the hay sweeps down over the outside of the stack.

The fundamentals of drying baled hay have been studied in some detail by various research workers [2 and 3] and recommendations made concerning moisture content and density at baling, method of stacking, loading depth, etc. Some of the recommendations have since been modified slightly in the light of experience, but there is no doubt about the advantage of getting moisture content down to about 35-40 per cent in the field wherever practicable, nor of the need to bale at a fairly low density. An air temperature rise of about 20°F is considered advantageous.

In a more recent article, A. Fineman [4] recommends keeping moisture content down to no more than 40-45 per cent, using short bales into which the hand can easily be pushed, and stacking the bales so that any vertical chimneys are eliminated. In practice, it does not make much difference if the bales are stacked with the cut edges downwards. There may be a slight advantage in this method of stacking for the first layer, but for subsequent layers it is more important to ensure that there is as much crossing of layers of bales as possible. It is generally agreed that six bales deep is about the maximum.

Airflows of up to 50 cu. ft/min per sq. ft can be usefully employed where no heat is used, but if there is a fairly high temperature rise, an airflow of 25 cu. ft/min per sq. ft is considered adequate.

An Efficient Two-bay Drier

One of the difficulties about drying baled hay is the tendency for the bales in the upper layers to separate as they shrink on drying. This makes it difficult both to get the top layers dried, and to avoid wasting a great deal of warm air in the last stages of drying. An ingenious type

of drier which has been developed at Rutgers University in an attempt to overcome both of these difficulties is described by Mark E. Singley [5]. The installation comprises a two-bay drier with a low dividing wall separating the two bays, and separate main ducts leading to each bay. There are two fans, one incorporated in the drier unit which has an oil-fired heat exchanger, and a separate exhaust fan. The entrances to the two ducts are at opposite sides of the building.

The drying cycle takes two days, and after the plant has been running for twenty-four hours the procedure each day is as follows: First, the bay containing fully dried hay is emptied. The floor area of 384 sq. ft produces about ten tons of dried baled hay each day. This empty bay is then filled with new bales at a moisture content of up to 40-45 per cent, stacked only four bales deep. The drier fan is connected up so as to blow up through the other bay which contains half-dried hay, while the exhaust fan draws the air from the half-dried hay, over the dividing wall, and down through the new batch. This ensures that the warm air is always used, first to finish drying the partly dried crop, and then to commence drying the new batch—the fans being interchanged each day as soon as re-loading has taken place. The result is claimed to be an unusually high degree of efficiency, together with a system that takes most of the gamble out of haymaking.

This article also describes what the author regards as intermediate systems on the road to the two-stage drier, including the drying of bales on special drying trailers, and "dolly" driers, in which a whole batch of bales is moved from trailer to drier on a kind of stillage, with the help of rollers. Some American farmers prefer to collect their hay by means of a field chopper (forage harvester), since it eases handling both in field and barn. The resistance to airflow of chopped hay is a little higher than that of loose or baled, but drying can be successful. It seems, however, that the drying of baled hay is at present becoming more popular in the U.S.A. than the drying of chopped hay—possibly because the bale method lends itself more readily to batch systems where a considerable amount of heat is used.

Developments in Sweden

During the last three years barn drying has become established in Sweden, largely owing to pioneering work by the Swedish Institute of Agricultural Engineering. Bulletin 263 [6] of the Swedish Institute (with English summary) gives a general account of the development of fodder conservation systems, and points out the advantages of barn drying over such methods as the use of fence racks. Mechanization of various rack drying systems led to some saving of labour, but the general conclusion drawn was that barn drying in conjunction with silage-making is likely to produce the best results.

Bulletin 267 [7] on the planning and construction of barn driers gives the results of experience gained in research on drying plants in ten

widely-spread places in Sweden, together with observations on twenty other driers which have been used for one to three years and on forty driers built in 1956. Chief recommendations are as follows:

Moisture Content at Loading: Not over 45 per cent for long loose hay; and 35-40 per cent for baled or chopped hay. Wherever possible, loading moisture contents should be lower than these figures.
Loading depth: up to 15 ft.
Air Speed: about 20 cu. ft/min. per sq. ft.
Type of Fan: axial flow preferred.
Heating of Air: not recommended.

With timber plentiful and cheap, it is not surprising that wooden-slatted floors are the most common type. Installation costs average about £9 per ton of capacity. Experimental work was carried out with radio-active air and geiger counters to determine such points as the effect of various widths of blanking off strips round the edges of the plenum chamber, in relation to loading heights and airtightness of bin walls. Results were usually in accord with expectations. One design feature established was the desirability of locating the fans on the side of the building from which the prevailing wind blows. It was found that appreciable re-circulation of damp air could otherwise occur. Location of the fan on the sunny side was unimportant, because in a few minutes the fan was drawing air from a considerable distance. Similarly, a portable fan with an adjustable inlet which could be extended on a specially designed extension pipe to a height of 20 ft or so indicated that there was nothing important to be gained by such a raised intake.

Drying with Cold Air

The reasons for advocating the use of only cold air are partly economic and partly explained by a climate which is generally at least as good as that of the London area.

Bulletin 264 of the Swedish Institute of Agricultural Engineering [8] gives comprehensive maps, graphs and tables showing the climate of Sweden in places ranging from the south to the region within the Arctic Circle. It is interesting to note that average relative humidity in summer within the Arctic Circle, where there is continuous daylight, is lower than that in South Sweden. This fact helps to justify the emphasis that is being placed on the use of cold air only for barn drying in Sweden.

A fourth Bulletin from the Swedish Institute [9] on procedure in barn drying, contains some interesting recommendations on crop husbandry aspects as well as on the actual drying operation. It had been recommended in Bulletin 263 that, as a general guide, approximately half the ley crops to be conserved should be ensiled and half barn dried. Bulletin 269 goes on to advise that the more grassy crops should be dried, and the more clovery ones ensiled. Surprisingly, it is recommended that the field work, which it is reckoned should be spread over three weeks only, should proceed more or less regardless of the official weather forecasts. If rain intervenes, the crop should be left out rather than

loaded too wet, and should be tedded as soon as rain ceases. Conclusions on the use of tedders and crushing machines are similar to those reached as a result of work in England at the National Institute of Agricultural Engineering—use of a tedder is essential, but use of a crusher tends to be tedious and costly. Tedding should be carried out immediately after mowing and then usually twice a day. The use by farmers of a simple moisture tester for determining when the hay is fit to load into the barn is recommended.

When more than one bay is used, the aim should be to work in turn on all of them, so that all the fans are working as soon as possible, and appreciable drying takes place before a further batch is added.

A recommendation that, in British conditions, would lead to trouble from fermentation and excessive heating, is one advising that the blowers may be switched off at night after two days. The Swedish recommendations envisage a certain amount of spontaneous heating in the hay, and it must be considered doubtful whether this will be found desirable in the long run.

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C.C.

Provincial Note

The Small Marginal Producer on Bodmin Moor

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EXTENSIVE PRODUCTION of store cattle and sheep should form the normal pattern of agriculture on Bodmin Moor. Since this class of stock must be wintered at home, it follows, therefore, that the limit of any farmer's size of business is determined by the amount of land he can devote at home to the production of hay, silage, kale and rape, and also by his available housing accommodation. During the summer, the stock are off the farms and on the adjoining open commons. The larger farms, therefore, are able to maintain a sizeable head of stock, the income from which is supplemented by Hill Cattle and Sheep Subsidies. Also, on a large farm there is often sufficient capital and income available for comprehensive improvements to land and buildings—expenditure which can be subsidized under the Livestock Rearing Improvement Scheme by as much as 50 per cent of the gross cost.

The Land

To appreciate the difficult farming conditions in this area, the land needs to be seen to be believed. A black peaty soil—subjected to an annual rainfall of about 80 in. spread evenly over the year—is often strewn with granite boulders, some of which in earlier days were dug out and used to build the massive stone banks around the fields. Nowadays, these banks have to be dearly maintained and topped with a sheep-proof fence, since by "Common Law" it is the farmer's obligation to fence against cattle and sheep on the commons. Pastures on this peaty land are variably drained and wet patches produce suitable environments for Fluke. The soil is extremely deficient in lime, phosphates and potash, and occasionally cobalt. Under such conditions pastures are difficult and expensive to maintain for any length of time, and sooner or later have to be ploughed.

This in turn reveals a host of new problems; first, the rocks to be blasted away; next, the liming and manuring, and then the difficult choice of crop. Corn is attempted but is rarely fully harvested—the soil, being organic, tends to produce a lot of straw which accentuates the difficulties of a wet harvest. Some areas are plagued with Corn Marigold ("Irish Molly" in these parts), a weed which is often impossible to control in these conditions. Kale crops are difficult, since the land is usually too wet for winter grazing. Other areas, after being under the plough for more than one year produce heavy infestations of articulated rush which are subsequently very difficult to control. There is a tendency

nowadays to plough for a catch crop of arable silage or rape and to follow as quickly as possible with direct reseed. £9-£10 per acre spent on lime and manure is needed to ensure the establishment of a reseed, and £5-£6 per acre annually to maintain it subsequently. Once properly established and maintained, these leys are very useful, particularly for grazing and silage production. The progress of such a programme towards better grassland management, is, however, dependent on the farmer's ability to provide the working capital and his having the technical knowledge to carry it out.

The "Small" Man

For every "big" man in this area, however, there are at least two "small" men, trying to exist on about 50 acres of marginal land. The small man is either an owner/occupier who has been born and bred on the place, or is a local man renting from a small local landlord (who is as short of capital as his tenant). His first problem is usually that, because of his small turnover, he cannot afford to wait for the doubtful return from store cattle, which in any case would not be large. He is therefore inclined to suckle fewer calves and pour milk into the churn. He is probably in difficulty over Milk Regulations and needs to spend a small amount of capital on improving his cowshed, dairy and water supply. If he wishes to progress towards attestation he is automatically prevented from using his common grazing rights and so his business has to become more intensive. Very often he is breeding and fattening a few pigs, usually entirely on purchased feedingstuffs. This development towards "cash production" renders him less eligible for assistance under the Livestock Rearing Scheme.

Having known the joys of a monthly cheque he is tempted to increase further his intensity of production. He sells his sheep, milks more cows and buys more cake; and then endeavours to grow more food on his land to economize on his cake bill.

The Remedies

Whether or not it is right to produce milk under these circumstances does not concern these small men unduly. Most of them know that to increase income to keep pace with the rising cost of living they have to farm more intensively; and the quickest way to this end is selling more, and feeding less milk. Many are well aware of the advantages that would follow the fencing-in of their common grazings. They feel that enclosure would not only facilitate the improvement of grazings, but would also permit better management and greater production. Under such circumstances, many farmers would, by the virtual enlargement of their farms, be able to practise the correct type of farming for their area—livestock rearing.

Enclosure would also encourage their progress towards attestation. But most of them, realizing that these are long-term projects, and knowing well that they cannot afford to wait, have to resort to milk.

What can be done to help them in these difficult circumstances? Whatever system will prevail in the long run will be based on good grassland management, and while waiting for national decisions to be made in respect of the common grazings, we can at least help to improve the grassland on the farms themselves.

The plight of these men makes them eager to follow sound advice, provided that it can be carried out within the income of the farm. Until the inception of the "Marginal Producer" aspect of the Marginal Production Scheme, we could not materially assist, since very often the farmer was simply not able to find the 50 per cent of the cost necessary to carry out any worthwhile programme. An 85 per cent grant, however, has made a great deal of difference, and several schemes are already in existence involving a comprehensive programme of grassland management, the purpose of which is mainly to save purchase feed costs by the greater production of home-grown feed, and at the same time to minimize lime and manure costs temporarily. The capital saved from such schemes can then be used in one or two years' time for some basic part of the farm economy, such as increasing the number of livestock. Typical of such a programme of grassland management is the following, planned for a 60-acre holding where net farm income is at present £300 and £100 capital is available.

Case No. 1

Schedule of Operations

Field A Plough out old pasture to rape, lime and manure and reseed in following year.
„ B Apply lime and slag to improve grazing.
„ C Crop to arable silage and then reseed.
„ D Strengthen boundary fence against common grazings.
„ E Apply manures for silage cut.
„ F Reclaim: remove rocks; lime and manure. Till to rape and then reseed.
„ G Erect new fence on one side of field "F".
„ H Apply lime and manures on recent leys.

	Gross Cost	*Current Subsidies*
	£	£
Ground Limestone	136	68
Spreading	34	17
Cultivations	75	49
Manures	221	109
Seeds	90	
Fencing	104	
Total	£660	£243

	£
Recommended Grant	317
Cost to Farmer	100

In preparing these schemes, it is often possible to obtain a clear insight into farm businesses, and the following two cases are presented as being fairly typical of local circumstances.

Case No. 2

Farm A (Milk, Beef Stores, Pigs)

7 acres permanent pasture	11 breeding cows (North Devons)
34 „ temporary leys	2 heifers-in-calf
7 „ arable silage and kale	6 yearlings
12 „ very rough grazing	6 under one-year-olds
—	5 fattening pigs
60 acres	100 poultry

Labour Force:
self and wife

overhead costs . .	£254	
feeds . . .	384	
lime and manures .	84	
net farm income .	214	Total Output . £936

In this case no capital was available to adapt buildings to allow for an increase of stock, and the necessary amount obviously could not be saved out of existing income. An 85 per cent Marginal Production Grant was awarded to cover a year's programme of grassland improvement and consequent increased production of home-grown feed. This programme should eliminate the present feed bill and most of the present lime and manure bill, and leave about £400 with which to increase stock. Help of this sort may be given again in a future year to ensure that the foundation of a satisfactory business is laid.

Case No. 3

Farm B (Milk and Sheep)

15 acres permanent pasture	10 milking cows (mixed)
21 „ temporary ley	2 heifers-in-calf
6 „ kale	3 yearlings
8 „ rape	3 under one-year-olds
—	20 breeding ewes (half crease)
50 acres	50 poultry

Labour Force:
self and wife

overhead costs . .	£830	
feeds . . .	680	
lime and manures .	150	
net farm income .	218	Total Output . £1,878

In this case, the farm had been purchased recently in poor condition, and available capital had been absorbed in a programme of restoration which had not been quite completed. A comprehensive plan of grassland management was adopted and the cost covered at 85 per cent, under the Marginal Production Scheme, bringing the expenditure on lime and manures up to £7 per acre.

The increased production of home-grown feed is expected to save £400 on purchased feeds, and £100 will be saved on lime and manures. This saving will be used to increase stock, and thereby income, in future years.

The Long-Term Policy

The policy of intensification on these small marginal farms can at the best raise the net farm income from very little to £12 per acre. On a 50-acre farm this is hardly sufficient income for a family man, let alone a return on his capital. In an economy of rising costs and standards of living it has limited long-term value.

Many people believe that the long-term policy must lie in a return to the true husbandry-livestock rearing, and that this can only be achieved by an enlargement of the units.

They believe that the first step towards this will be the enclosure and apportioning of the commons, and their subsequent improvement. They argue that this measure alone might increase the size of the smaller holdings by 100 per cent. Eventually, however, they admit, there may have to be some amalgamation of holdings. Consequent enlargement in the size of farm businesses, they say, would facilitate the application of the Livestock Rearing Schemes and would tend to encourage the establishment of a true livestock rearing husbandry in these marginal areas. Pending these developments, however, most are agreed, that any measure which will increase income and at the same time improve the quality of the land and build up fertility is surely justified.

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